PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Grande Ronde Basin Spring Chinook Captive Broodstock Program

BPA project number: 9801001
Contract renewal date (mm/yyyy): 10/1999 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Oregon Department of Fish and Wildlife

Business acronym (if appropriate) ODFW

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
7.1B Conserve Genetic Diversity; 7.2 Improve Existing Hatchery Production; 7.2D Improve Propagation at Existing Facilities; 7.3B Implement High Priority Supplementation Projects; 7.4A, 7.4D, 7.4D2 Implement Captive Broodstock

FWS/NMFS Biological Opinion Number(s) which this project addresses
The biological opinion for Hatchery Actions (page 67, Section 10.B.3 and 4) states "USFWS should terminate use of Rapid River stock at Lookingglass Hatchery no later than 1996" and "The USFWS should consider development of indigenous broodstock…"

Other planning document references
Captive broodstock programs for Snake River spring/summer chinook salmon are supported by Snake River Recovery Team recommendations (SRSR, 1994) NMFS (1995a) draft recovery plan, and Wy-Kan-Ush-Me Wa-Kush-Wit Plan (Volume II page 116).

Short description
Implement captive broodstock programs and associated research, monitoring, evaluation, and fish health for spring chinook salmon populations in Catherine Creek, upper Grande Ronde and Lostine rivers, to conserve genetic diversity and assist in recovery.

Target species
Spring Chinook Salmon

Section 2. Sorting and evaluation

Subbasin

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☐ Research & monitoring ☒ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
20512	Grande Ronde River Subbasin
9801001	Grande Ronde Basin Spring Chinook Captive Broodstock Program

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9202604	Early Life History of Spring Chinook Salmon in the Grande Ronde Basin.	We utilize migration timing information from this project to determine when to collect juveniles for captive broodstock. Life history information will also be used to access the success of supplementation programs and smolt migration success.
8805301	NE Oregon Hatcheries - ODFW, CTUIR, and NPT.	Captive broodstock program will be directly integrated into the NE Oregon Hatcheries program as it will be providing the broodstock and eggs that will be utilized for NEOH.
8905302	NE Oregon Hatcheries - ODFW, CTUIR, and NPT.	Captive broodstock program will be directly integrated into the NE Oregon Hatcheries program as it will be providing the broodstock and eggs that will be utilitzed for NEOH.
5520700	Captive Broodstock Artificial Propagation	This is the NPT funding for cooperative evaluation of the Grande Ronde Spring Chinook Captive Broodstock Program.
8909600	Genetic Monitoring and Evaluation of Snake River Salmon and Steelhead.	This project provides samples for the genetics montoring program.
	Fish Passage Center Smolt Montoring Program - Migration Characteristics	During the summer, we PIT-tag parr in Catherine Creek, and the Lostine and Grande Ronde rivers. We collect parr for the captive broodstock when parr PIT-tagging occurs. This project also provides personnel and information to improve efficiencies.

9606700	Captive Broodstock Program - Manchester Marine Lab	This is a NMFS project that rears Grande Ronde Captive Broodstock as a part of the program.
	Spring Chinook Endemic Broodstock Development	This captive broodstock program is integrated with the Grande Ronde Endemic program and will utilize the adult collection facilities to monitor returns and survival of captive broodstock produced returns.
	Lower Snake River Compensation Plan	The captive broodstock project is providing embryos for use in the LSRCP supplementation program. Production and release of captive brood progeny is funded under the LSRCP.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1995	Collected 1994 brood juveniles from Catherine Creek, Grande Ronde and Lostine rivers.	Yes
1996	Completed long-term management plan for captive broodstock program and obtained an ESA permit.	Yes
1996	Collected 1995 brood juveniles from Catherine Creek and the Lostine River.	Yes
1996	Cryopreserved semen from mature 1994 brood males.	Yes
1997	Completed designs for new facilities for captive brood at Bonneville Fish Hatchery and Manchester Marine Lab. Completed NPPC review process and received approval for funding and construction. Began construction.	Yes
1997	Transferred 1995 brood juveniles and cryopreserved semen from mature 1994 and 1995 brood males.	Yes
1997	Collected 1996 brood juveniles from Catherine Creek, the Grande Ronde and Lostine rivers.	Yes
1997	Began construction of Bonneville and Manchester Captive Broodstock facilities.	Yes
1998	Collected 1997 brood juveniles from Catherine Creek, the Grande Ronde and Lostine rivers. Transferred 1996 brood to Bonneville and Manchester Hatcheries.	Yes
1998	Sorted mature females and males at Bonneville and Manchester Hatcheries, and spawned 119, 1994 and one, 1995 brood females. Transferred embryos to Irrigon Hatchery for incubation.	Yes
1998	Completed construction of Bonneville and Manchester Captive Broodstock facilities.	Yes

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Assess maturation and characterize length, weight, and survival of all three stocks at Manchester Marine Laboratory and at Bonneville Fish Hatchery to assess the success of alternative rearing treatments.	a	Examine 1995, 96, 97 and 98 brood fish for maturation at BOH and MML. At all sample times, we will inventory each stock and collect lengths and weights from a subsample to assess growth and condition.
2	Monitor the growth, development, and survival of the fish at Lookingglass Fish Hatchery to assess the success of alternative rearing treatments.	a	Measure the length and weight of a sample of fish from each stock on a monthly basis, until March, when final smolt development should begin.
3	Mark all 1998 brood individuals in all three stocks with a secondary mark.	a	Apply VI tags as a secondary mark to all individuals in each stock. The VI tags will provide a backup identification to the PIT tags to ensure that individuals can be identified.
4	Determine when fish are ready to be transferred to seawater.	a	Rear a surrogate stock as similarly as possible to our seawater/natural growth fish. Fish will then be used in salinity tolerance tests.
5	Collect 1999 brood juveniles from Catherine Creek, Lostine River, and upper Grande Ronde River populations.	a	Collect 500 parr in August and September throughout the rearing area from each population.
6	Coordinate ESA permit activities and participate in captive broodstock planning and oversight.	a	Continue leadership of the Grande Ronde Chinook Captive Broodstock Project, Technical Oversight Team and participate in the Chinook Technical Oversight Committee.
7	Develop and implement complex matrix spawning protocols.	a	Develop the most appropriate spawning protocols. Sample fish as they are spawned.
8	Develop and maintain a database on the captive fish.	a	Maintain a database for each individual fish. This database will include PIT and VI tag identification numbers, growth information, information on maturation, and survival.
9	Insure that an Annual Operations Plan is developed for the captive broodstock program.	a	Coordinate and oversee the development and implementation of the Annual Operations Plan for the captive broodstock program.
10	Analyze and summarize data, and prepare and submit an annual report.	a	Write and submit an annual report covering the period of October 1, 1999 **-** September 20, 2000. We will also provide an ESA permit report to NMFS on our annual operations.
11	Determine etiology of captive broodstock morbidity and mortality.	a	Conduct diagnostic examinations using appropriate methods to identify infectious and disease causing agents.
		b	Make observations to attempt to identify any other causes of morbidity and mortality.
		c	Complete and distribute diagnostic reports.
12	Implement prophylactic erythromycin treatments for bacterial kidney disease under Investigational New Animal Drug	a	Prepare annual protocols and submit to the INAD primary investigator.

	(INAD) protocols.		
		b	Coordinate protocols with hatchery personnel.
		c	Complete submission of annual protocols with Efficacy of Treatment forms to the primary investigator.
13	Implement theraputic treatments as described in the Section 10 ESA permit.	a	Prepare INAD protocols when required.
		b	Evaluate therapy through completion of Efficacy of Treatment forms.
14	Monitor fish culture practices and fish handling for situations that may contribute to impaired fish health or exacerbate disease.	a	Maintain liaison with hatchery personnel and others handling the fish to obtain information.
		b	Recommend changes to procedures that may contribute to impaired fish health or exacerbate disease.
		c	Prepare a table of findings from diagnostic examinations.
		d	Identify disease treatments required.
		e	Identify any recommended changes to fish culture operations.
15	Rear 1998 brood year parr until they reach smoltification at Lookingglass Fish Hatchery.	a	Provide all facilities, feed and personnel to rear 1998 brood until smoltification.
		b	Provide an adequate quantity and quality of water, and chilling facilities adequate to meet program requirements.
16	Safely transport 1998 brood fish to Bonneville Fish Hatchery and Manchester Marine Laboratory following smoltification.	a	Move 1998 brood fish from LFH to BOH and MML following smoltification at LFH.
17	Rear all 1995, 1996, 1997 and 1998 brood fish at Bonneville Fish Hatchery.	a	Provide all facilities, feed and personnel to rear all adult 1995, 1996, 1997 and 1998 brood until they are ready to spawn.
18	Oversee and facilitate the spawning of all ripe 1995, 1996, 1997 and 1998 fish.	a	Provide all facilities, feed and personnel to spawn all 1995, 1996, 1997 and 1998 brood.
		b	Transport fertilized embryos to LSRCP facilities for incubation.
19	Rear 1999 brood after collection and rearing at Lookingglass Fish Hatchery.	a	Provide all facilities, feed and personnel to rear 1999 brood.
20	Determine and compare success of alternative rearing profiles including fast growth vs. natural growth during juvenile phase and saltwater vs. freshwater during ocean growth phase.	a	Measure and compare survival from collection to spawning.
		b	Measure and compare growth rates.
		c	Measure and compare maturation schedule, fecundity, egg size and embryo viability.
		d	Measure and compare embryo-to-smolt survival.
		e	Measure and compare smolt-to-adult

			survival.
21	Assess the effectiveness of captive broodstock programs for use in recovery of salmonids.	a	Analyze fish culture performance data, smolt-to-adult survival and performance of F1 fish in fresh water to assess effectiveness.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	9/2000	Length and weight at age comparable to natural fish. Survival rates acceptable.		3.00%
2	10/1999	9/2000	Growth rates similar to natural fish.		2.00%
3	10/1999	11/1999	VI tags applied with high retention rate and readable. Fish remain identifiable throughout entire life.		2.00%
4	3/2000	6/2000	Determine optimal seawater transfer date.		2.00%
5	8/2000	10/2000	Complete collection of 500 parr from all three stocks.		5.00%
6	10/1999	9/2000	None		3.00%
7	10/1999	9/2000	Develop spawning matrices to ensure diversity of family groups.		2.00%
8	10/1999	9/2000	None		3.00%
9	12/1999	3/2000	None		3.00%
10	10/1999	9/2000	None		4.00%
11	10/1999	9/2000	Identify diseases.		3.00%
12	10/1999	9/2000	Identify disease treatments.		3.00%
13	10/1999	9/2000	Ensure treatment applied correctly.		4.00%
14	10/1999	9/2000	Adapt and improve fish culture practices.		4.00%
15	10/1999	6/2000	Successfully rear 1998 brood to the smolt stage.		5.00%
16	5/2000	6/2000	Succesfully transport with little or no mortality.		2.00%
17	10/1999	9/2000	Successfully rear 1995 - 1998 broods.		30.00%
18	10/1999	9/2000	Successfully spawn 1995-1998 broods and successfully transport embryos.		5.00%
19	8/2000	9/2000	Successfully rear 1999 brood.		5.00%
20	10/1999	9/2000	Determine most successful strategies by comparing performance.		5.00%
21	10/1999	9/2000	Determine effectiveness by assessing culture, post release, and natural production performance.		5.00%

				Total	100.00%

Schedule constraints
None

Completion date
At least until 2010

Section 5. Budget

FY99 project budget (BPA obligated): $540,806

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel		%36	234,000
Fringe benefits		%14	89,176
Supplies, materials, non-expendable property		%13	83,025
Operations & maintenance		%8	50,000
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	0
NEPA costs		%0	0
Construction-related support		%0	0
PIT tags	# of tags: 1700	%1	4,930
Travel		%3	18,400
Indirect costs		%26	166,566
Subcontractor		%0	0
Other		%0	
TOTAL BPA FY2000 BUDGET REQUEST			$646,097

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		%0	
		%0	
		%0	
		%0	
Total project cost (including BPA portion)			$646,097

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$655,000	$688,000	$723,000	$759,000

Section 6. References

Watershed?	Reference
☐	Appleby, A. and K. Keown. 1995 History of White River spring chinook broodstock and captive brood rearing efforts, In (Flagg and Mahnken, eds.) An assessment of the status of captive broodstock technology for pacific salmon. Bonneville Power Adminis …
☐	Burck, W. 1994. Life history of spring chinook salmon in Lookingglass Creek, Oregon. Information Report, Oregon Department of Fish and Wildlife, Report No. 94-1, Portland, OR.
☐	Flagg, T.A., and V.W. Mahnken. 1995. An assessment of the status of captive broodstock technology for Pacific Salmon. Draft Report to the Bonneville Power Administration, contract DE-AI79-93-BP55064, Project 93-56, Portland, OR.
☐	Hankin, D.G., J.W. Nicholas, and T.W. Downey. 1993. Evidence of inheritance of age at maturity in chinook salmon (Oncorhynchus tshawytscha). Can. J. Fish. Aquat. Sci., 50(2):347-358.
☐	Nielson, J.D. and G.H. Geen. 1986. First-year growth rate of Sixes River chinook salmon as inferred from otoliths: effects on mortality and age at maturity. Trans. Amer. Fish. Soc. 115:28-33.
☐	NMFS. 1995. Proposed recovery plan for Snake River salmon U.S. Department of Commerce, NOAA, Portland, OR.
☐	NPPC (Northwest Power Planning Council). 1994. 1994 Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council, Portland, OR.
☐	ODFW 1995. Application For A Permit For Scientific Purposes & To Enhance The Propagation Or Survival Of Endangered Grande Ronde River Basin Spring Chinook Salmon Oncorhynchus tshawytscha Under The Endangered Species Act, Portland, OR.
☐	ODFW (Oregon Department of Fish and Wildlife.) 1996. Grande Ronde Basin Captive Broodstock Section 10 Permit for a take of endangered/threatened species, Portland, OR.
☐	Smith, C.J. and P. Wampler. 1995. Dungeness River chinook salmon rebuilding project progress report 1992-1993. Northwest Fishery Resource Bulletin, Project report series No. 3, Washington Department of Fish and Wildlife, Olympia, WA.
☐	SRSRT (Snake River Salmon Recovery Team). 1994. Final recommendations to the National Marine Fisheries Service, Portland, OR.
☐	Witczak, Daniel. 1995. Dungeness chinook restoration project - data accumulation 1993 - 1995. Washington Department of Fish and Wildlife. Olympia, WA
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PART II - NARRATIVE

Section 7. Abstract

This program was initiated as a conservation measure in response to severely declining runs of chinook salmon in the Grande Ronde Basin. Our goals are to help prevent extinction of the three populations; provide a future basis to reverse the decline in stock abundance of Grande Ronde River chinook salmon; and ensure a high probability of population persistence well into the future once the causes of basin wide population declines have been addressed. Associated objectives include: 1) to reduce the demographic risk associated with the decline of native wild chinook populations in the Lostine River, upper Grande Ronde River and Catherine Creek, 2) maintain genetic diversity of indigenous artificially propagated chinook populations, 3) maintain genetic diversity in wild chinook populations, 4) assess the effectiveness of captive broodstock for use in

recovery of chinook salmon, and 5) determine most effective treatments for captive broodstock programs.

We have collected naturally-produced juveniles for four years (1995-98), and reared these juveniles to the smolt stage at Lookingglass Fish Hatchery (LFH). Two-thirds of these smolts were transferred to Bonneville Fish Hatchery (BOH) and reared in freshwater and one-third to NMFS Manchester Marine Lab (MML) and reared in saltwater. Fish are reared at these facilities to maturity. We plan to continue collecting juveniles on an annual basis. Maturing adults are transported from MML to BOH and all fish are spawned at BOH. One hundred twenty 1994 brood females were spawned at BOH in 1998 and the embryos were transferred to the LSRCP program. Captive broodstock progeny will be reared to the smolt stage at LFH. We anticipate our first smolt release in 2000 from the spawn in 1998. These smolts will be released into the river of parent origin. When the program is at full production, a minimum of 150 adults should return to the river of parent origin, to ensure threshold escapement levels are met.

Section 8. Project description

a. Technical and/or scientific background

The Grande Ronde basin once supported large runs of chinook salmon with estimated escapements in excess of 10,000 as recently as the late 1950's. Natural escapement declines in the Grande Ronde basin have paralleled those of other Snake River stocks. Catherine Creek, Grande Ronde, and Lostine rivers were historically three of the most productive populations in the Grande Ronde basin. Escapement levels in these three rivers dropped to alarming low levels in 1994 and 1995. Present escapement levels and recent trends indicate that Grande Ronde basin spring chinook are in imminent danger of extinction. Progeny-to-parent ratios have been below 1.0 for the past eight completed broodyears. We are presently in an emergency situation where dramatic and unprecedented efforts are needed to prevent extinction as well as preserve any future options for use of natural fish for artificial propagation programs. The initial management plan under the LSRCP program called for hatchery supplementation of four chinook populations in the basin: Catherine Creek, as well as Wallowa, Grande Ronde, and Lostine rivers. The Oregon Department of Fish and Wildlife, U. S. Fish and Wildlife Service, and the Nez Perce Tribe decided to begin immediate development of broodstocks from local natural populations for genetic conservation and natural production enhancement. This decision was a result of a number of factors including: increased emphasis on natural production and endemic stock recovery; consultations and requirements resulting from listing of Grande Ronde chinook populations as endangered; our lack of success in using non-local hatchery stocks for supplementing Grande Ronde chinook populations; and preferred strategies for use of artificial propagation identified in the NMFS draft recovery plan. It is too early in the program to provide significant results, however we believe that this program will provide substantial new knowledge for the use of artificial propagation to enhance natural production.

Captive breeding programs have been used extensively in recovery efforts for fishes as well as other vertebrates. Only recently has this type of propagation approach been attempted with Pacific salmon in the Northwest. Similar broodstock programs are underway for a number of other listed salmonids including: Sacramento Winter Chinook, Redfish Lake Sockeye, Salmon River Spring Chinook, White River, and Dungeness Chinook (WA). We have used the knowledge and experience gained in these other programs as well as the results of the captive broodstock comprehensive review conducted by Flagg and Mahnken to develop the culture, research, and monitoring and evaluation for this program.

Project success is dependent on achievement of adequate survival, growth, maturation, gamete viability, smolt-to-adult survival and reproductive success objectives. Recovery of these populations is dependent on improved juvenile and adult survival through mainstem reservoirs and dams. Detailed assumptions used to develop the production program are described below:

1. We anticipate a 1:1 sex ratio at collection for each population.
2. Recent data suggest that 50% of the parr we collect are likely to survive to spawn (Smith and Wampler, 1995.) The 90% survival from parr to smolt at LFH during the first year of a program, 80% survival from smolt to three year adult for spring chinook in Washington's Dungeness program (Witczak 1995) and 90% first year survival observed for juvenile Redfish Lake sockeye held at MML (C. Mahnken, NMFS, Seattle, personal communication) suggest it is unlikely we will need to collect more than 500 juveniles. Thus, the model is based on a collection of 500 juveniles each year from 1995-2000.
3. We predict that approximately 6% of the females will mature at age 3, 78% at age 4 and 16% at age 5 (adapted from Nielson and Geen, 1986; Hankin et al., 1993; Burck, 1994; Appleby and Keown, 1995).
4. Based on the information reported in Flagg and Mahnken (1995), we expect fecundities to be approximately 1,200, 3,000, and 4,000 eggs for age 3, age 4, and age 5 females, respectively.
5. This production model assumed a 75% embryo viability (see Smith and Wampler, 1995), and 80% viable embryo to smolt survival (unpublished data from the program at LFH). In our 1995 permit application we use an estimate of 45% embryo viability. More recent data suggests that 75% embryo viability might be reasonable to expect (Flagg and Mahnken, 1995). Higher than expected embryo viability and embryo-to-smolt survival may require a reduction in the number of juveniles that are collected in the future.
6. Typically, chinook reared at and released from LFH return at a 0.1% smolt-to-adult survival rate.
7. Data from previous programs at LFH suggests that 10%, 60%, and 30% of the adults will return at ages 3, 4, and 5, respectively.
8. The estimates of maturation rates and survival are based on the history of production at LFH and additional studies cited above.
9. Based on recent modeling, 500 parr or less would be sufficient to produce the needed smolts. Our goal for 1995-1998 was to collect 500 parr from each stream. The number of parr collected should then be reassessed prior to the collection in 1999. If the needed number of parr is reduced, the minimum number collected should be 300. Any less will be difficult to manage as we split the populations between sites and strategies, and potentially could represent a lesser number of parents for the original stock.

b. Rationale and significance to Regional Programs

Captive broodstock projects for Snake River spring/summer chinook salmon are supported by recommendations in the Snake River Recovery Team's report (SRSRT 1994), NMFS draft recovery plan (NMFS, 1995), and the Northwest Power Planning Council's Fish and Wildlife Program (NPPC, 1994). This project addresses numerous objectives identified in the 1994 Fish and Wildlife Program including: 7.1B which addresses conservation of genetic diversity; 7.2 which identifies the need for improvement of existing hatchery production; 7.3B which directs implementation of high priority supplementation projects; 7.4A which specifies the need to evaluate and implement new production initiatives; and 7.4D which directs implementation of captive broodstock programs. NMFS draft recovery plan states "captive broodstock and supplementation programs should be initiated and/or continued for populations identified as being at imminent risk of extinction, facing severe inbreeding depression, or facing demographic risks". The recovery plan also states "considering the critical low abundance of the Grande Ronde spring/summer chinook salmon, impacts to listed fish should be avoided and LFH should be operated to prevent extinction of local populations. Consequently indigenous broodstock should be immediately transferred to LFH (natural fish collected in 1995), and production should be maximized to supplement natural populations." Our goal is to help prevent extinction of the three populations and provide a future basis to reverse the decline in stock abundance and ensure a high probability of population persistence. Use of non-local broodstock is inconsistent with sound conservation principles and development of local broodstocks was recommended by an Independent Scientific Review Panel under U.S. vs. Oregon Grande Ronde Chinook dispute resolution in 1996. This project is directed by the conceptual premise that identifies maintenance within and between population variations in genetic and life history characteristics as essential for long term fitness and persistence. It is an integral part of the LSRCP in-kind and in-place mitigation program.

c. Relationships to other projects

This captive broodstock project is one of the first such production projects in the Columbia Basin and is completely integrated with the LSRCP. Embryos produced from spawned captive brood become the source for smolt production under the Grande Ronde Basin Chinook LSRCP. Additionally this captive broodstock project is a large scale adaptive management program that is looking at three production strategies: a) accelerated presmolt rearing with post-smolt freshwater rearing, b) natural presmolt rearing with post-smolt freshwater rearing, and c) natural presmolt rearing with post-smolt seawater rearing. The project is closely integrated with other hatchery, habitat and research projects in the Grande Ronde Basin.

1) Bonneville Hatchery Operations - (NMFS funding): The captive broodstock production facility was completed at BOH in May 1998. Management personnel at Bonneville will be overseeing the production program and we will be sharing equipment and personnel with BOH. All opportunities to maximize efficiency will be sought.

2) LSRCP Hatchery Operations and Evaluations: This captive broodstock project is completely integrated with the LSRCP Program. LSRCP facilities and personnel are implementing the production, evaluations, and fish health monitoring for the captive brood program. Extensive sharing is occurring between the programs. In addition, ongoing research under LSRCP will be providing information to assess the success of the captive broodstock project.

3) The Northwest Power Planning Council's Fish and Wildlife Program (NPPC 1994) calls for initiation of captive broodstocks and associated research, Measure 7.4.D.2 requests the Bonneville Power Administration to "fund captive brood stock demonstration projects identified under the coordinated habitat and production process."

4) Captive broodstock and supplementation projects for Snake River spring/summer chinook salmon: These projects are supported by Snake River Recovery Team recommendations (SRSRT, 1994) and NMFS (1995) draft recovery plan. NMFS draft recovery plan states "captive broodstock and supplementation programs should be initiated and/or continued for populations identified as being at imminent risk of extinction, facing severe inbreeding depression, or facing demographic risks" and further states "considering the critical low abundance of Grande Ronde spring/summer chinook salmon, impacts to listed fish should be avoided and LFH should be operated to prevent extinction of local populations. Consequently indigenous broodstock should be immediately transferred to LFH (natural fish collected in 1995), and production should be maximized to supplement natural populations."

5) Early life history of spring chinook salmon in the Grande Ronde Basin: This project will provide data on migration and survival of hatchery and naturally produced fish that is essential for evaluating the success of the captive broodstock project.

6) NMFS Manchester captive broodstock: This program conducts the ocean rearing phase – seawater treatment for all three stocks. It is an essential project component.

d. Project history (for ongoing projects)

This captive broodstock project was initiated in the Grande Ronde basin in 1995. Spring chinook juveniles were collected from Catherine Creek and the Lostine River in 1995, 1996, 1997 and 1998. Spring chinook juveniles were collected from the upper Grande Ronde River in 1995, 1997, and 1998. Fish from 1995–1997 collections were reared at LFH until the yearling smolt stage and then were transferred to facilities at BOH and MML. Fish from the 1998 collections are being reared at LFH. We completed a comprehensive plan for the captive broodstock program and were issued a NMFS, ESA Section 10 permit in 1996. This work was initially funded by the USFWS under LSRCP. It was transferred to the FWP in FY1998 as Project 9801001. FY98 funding was $418,500 and FY99 funding is $540,806. The following reports have been produced:

Comprehensive Plan for Grande Ronde Basin Spring Chinook Captive Broodstocks Section 10 Application (ODFW, 1995).
Section 10 ESA Permit (ODFW, 1996).
Grande Ronde Captive Broodstock Annual Operations Plan.

Major results achieved:

1995 Collections
A total of 498, 110 and 498 fish were collected from Catherine Creek, the upper Grande Ronde River, and the Lostine River respectively in August and September 1995. As of October 31, 1998 there were approximately 147, 8 and 79 fish remaining alive from Catherine Creek, the upper Grande Ronde and Lostine rivers respectively. Of the Catherine Creek fish no longer alive, approximately 243 have been spawned or had semen cryopreserved, 10 have died from disease and 98 have died from other causes. Of the upper Grande Ronde River fish no longer alive, approximately 25 have been spawned or had semen cryopreserved, 23 have died from disease and 54 have died from other causes. Of the Lostine River fish no longer alive, approximately 184 have been spawned or had semen cryopreserved, 70 have died from disease and 165 have died from other causes. Between September 11and October 28, 1998 fish were spawned on eight occasions. A total of 171 (BY)94 fish were spawned or had semen cryopreserved, 119 females and 52 males. Approximately 92% (109) of the 119 females that were spawned, were spawned during a three and one-half week period between September 29 and October 21. Prior to spawning maturity sorts were conducted on a monthly basis at MML and BOH.

1996 Collections
A total of 500 and 481 fish were collected from Catherine Creek and the Lostine River respectively during August and September 1996. As of October 31, 1998 there were approximately 235 and 208 fish remaining alive from Catherine Creek and the Lostine River, respectively. Of the Catherine Creek fish no longer alive, approximately 97 have been spawned or had semen cryopreserved, 42 have died from disease and 126 have died from other causes. Of the Lostine River fish no longer alive, approximately 142 have been spawned or had semen cryopreserved, 45 have died from disease and 86 have died from other causes. Between

September 11 and October 28, 1998 a total of 131 males were used to spawn with BY94 females; an additional 70 males had semen cryopreserved. One BY95 female was spawned on October 28.

1997 Collections

A total of 500 fish from each of the three stocks, Catherine Creek, upper Grande Ronde and Lostine rivers, respectively were collected in August and September 1997. As of October 31, 1998 there were approximately 476, 474 and 457 fish remaining alive from Catherine Creek, the upper Grande Ronde and the Lostine rivers respectively. Of the Catherine Creek fish no longer alive, approximately 12 have been spawned or had semen cryopreserved and 12 have died from other causes. Of the upper Grande Ronde River fish no longer alive, approximately 11 have been spawned or had semen cryopreserved and 15 have died from other causes. Of the Lostine River fish no longer alive, approximately 31 have been spawned or had semen cryopreserved. One died from disease and 11 have died from other causes. A complete inventory and vibrio vaccinations of all BY96 fish occurred April 1 and 2. Salinity tolerance tests were conducted and sentinel groups were sent to MML in April and May. All fish were transferred to BOH and MML in late May and early June. Twenty-seven males were used in spawning with BY94 and BY95 females, and an additional 27 had their semen cryopreserved. Most males were live spawned or live cryoed, but three were killed during spawning or cryopreservation procedures.

1998 Collections

As in previous years, juvenile salmon were collected using a passive seining technique that combines snorkeling and seining. Using this method, 500 spring chinook salmon parr from each of the three stocks were collected, during August and September 1998. Length and weight measurements were taken from all fish and each fish was given a prophylactic injection of erythromycin. Approximately two months following collection, all fish were again weighed and measured, fin samples were taken for genetics analysis, and they were PIT-tagged. A total of seven fish died by October 31, 1998; 3 Catherine Creek, 1 upper Grande Ronde River, and 3 Lostine River. Only one Catherine Creek fish died from BKD, all other mortalities were from other causes.

e. Proposal objectives

The long-term objectives of this captive broodstock program are:

1) Reduce the demographic risks associated with the decline of native wild populations in the Lostine and upper Grande Ronde rivers and Catherine Creek.
2) Maintain genetic diversity of indigenous artificially propagated chinook populations.
3) Maintain genetic diversity of wild populations.
4) Develop indigenous broodstocks for Grande Ronde chinook hatchery program.
5) Modify facilities at Bonneville and Lookingglass fish hatcheries to provide capability to implement captive broodstock programs.
6) Assess captive broodstock program performance in achieving adult broodstock, smolt production, adult return goals, and management objectives.
7) Determine optimum program operational criteria to ensure success of achieving objectives.
8) Assess the utility of captive broodstock programs for use in recovery of salmonids.

Measurable, annual objectives of this captive broodstock program are:

1) Assess maturation and characterize length, weight, and survival of all three stocks at MML and at BOH.

2) Monitor the growth, development, and survival of the fish at LFH.
3) Mark all BY98 individuals in all three stocks with a secondary mark.
4) Determine when fish are ready to be transferred to seawater.
5) Collect BY99 brood juveniles from Catherine Creek, Lostine River, and upper Grande Ronde River populations.
6) Coordinate ESA permit activities and participate in captive broodstock planning and oversight.
7) Develop and implement complex matrix spawning protocols.
8) Develop and maintain a database on the captive fish.
9) Insure that an Annual Operations Plan is developed for the captive broodstock project.
10) Analyze and summarize data and prepare and submit an annual report.
11) Determine etiology of captive broodstock morbidity and mortality.
12) Implement prophylactic erythromycin treatments for bacterial kidney disease under Investigational New Animal Drug (INAD) protocols.
13) Implement therapeutic treatments as described in the Section 10 permit.
14) Monitor fish culture practices and fish handling for situations that may contribute to impaired fish health or exacerbate disease.
15) Rear BY98 broodyear parr until they reach smoltification at LFH.
16) Safely transport BY98 brood fish to BOH and MML following smoltification.
17) Rear all 1995, 1996, 1997 and 1998 gravelyear fish at BOH.
18) Oversee and facilitate the spawning of all ripe 1995, 1996, 1997, and 1998 gravelyear fish.

f. Methods

We plan to collect naturally-produced juveniles for a minimum of five years (longer if the program demonstrates early success), rear the juveniles to near smolt stage at LFH, transport two-thirds as smolts to BOH and one-third as smolts to MML, respectively, rear fish at those facilities to maturity. Rearing fish at two facilities guards against catastrophic losses at one location. Maturing adults will be transported from MML to BOH. All these fish will be spawned at BOH. Embryos will be transported to LFH for final incubation and rearing to the smolt stage. Resulting smolts will be released into the river of parent origin. Other potential release strategies include outplanting of adults, eggs, or parr, produced in excess of smolt needs, directly into unseeded historic production areas. This project will be operated under an adaptive management philosophy. It will rely extensively on monitoring and evaluation results. New knowledge will be used when making future decisions and to adapt project approaches.

There are numerous uncertainties associated with salmonid captive broodstock project (Flagg and Mahnken, 1995). There is a need to evaluate experimentally various aspects of rearing and spawning captive salmonids. However, each evaluation has varying degrees of risk to or impact on the population associated with an experiment. Since we are working with endangered stocks of spring chinook salmon, we need to balance information needs with risks to the captive populations. Thus, we are proposing to evaluate aspects of captive rearing and breeding that address relatively important uncertainties, but will have minimal impact to the groups of fish being studied.

The first evaluation we propose is a comparison of fish reared exclusively in fresh water to those reared in fresh water as juveniles, sea water as adults, and returned to fresh water for final maturation. Fish in the first evaluation will be reared under simulated natural growth rates. The second evaluation we propose is a comparison of fish that, as juveniles, are grown at either a natural rate or an accelerated rate. Growth rates will be manipulated using water temperature and feeding levels. Fish growing at a natural rate will be reared in water temperatures (5-14°C) that simulate the natural water temperature cycle. Fish growing at an accelerated rate will be reared in constant 14°C water. Feeding will be adjusted according to water temperature. Fish in the second evaluation will be reared exclusively in fresh water. In each evaluation, we will compare the overall performance of captive fish and their progeny.

Beginning with the 1995 brood of captive fish, the two evaluations that we are conducting can be accomplished by dividing each stock of captive fish into three groups (by broodyear). Thus, for any given brood we will have a total of nine groups of fish (see table 2). Approximately two-thirds of the fish will be reared in fresh water while the other third will be reared in sea water. The freshwater, natural growth group of each stock will serve as a control for both the other treatments. Variables other than environmental salinity, juvenile growth rate, and perhaps adult diet will remain as similar between treatments as possible. For example, at all times, all fish will be reared under a simulated natural photoperiod. Treatment groups will always be kept separate and brood years will be kept separate until maturation. Fish from different broodyears within a treatment group will be spawned together. After spawning, F1-generation fish resulting from parents of a certain treatment group will be kept separate from F1-generation fish resulting from parents of a different treatment group until marking. F1 fish will be reared to the smolt stage.

This entire cycle should take between 3.5 and 5.5 years. For example, fish collected in September 1995 would spawn at age 5 in September 1999 and the resulting progeny would be released as smolts in the spring of 2001. For the purpose of clarifying the terminology associated with the monitoring and evaluation plan, we have divided this cycle into four periods (see table 3). The Captive Juvenile period begins at collection and ends once fish have been transferred to BOH or MML. The captive juvenile period is composed of two shorter periods; pre-smolt growth and smoltification. The Captive Adult period begins once fish have been transferred to BOH or the MML and ends once fish have been spawned or die. The captive adult period is composed of three shorter periods; post-smolt growth, maturation, and spawning.

Table 2. Approximate number and rearing location for captive brood post-smolts. (BOH = Bonneville Fish Hatchery; MML = Manchester Marine Lab).

Treatment	Stock		
	Lostine River	Catherine Creek	Grande Ronde River
Freshwater,			
fast growth	n=166 @BOH	n=166 @BOH	n=166 @BOH
natural growth	n=166 @BOH	n=166 @BOH	n=166 @BOH
Seawater,			
natural growth	n=166 @MML	n=166 @MML	n=166 @MML

The F1-Generation period begins once embryos from captive fish are formed and ends when fish from these embryos die. The F1-generation period is composed of four shorter periods; incubation, juvenile rearing, smolt release, and maturation. The F2-Generation period begins once embryos from F1-Generation fish are formed and ends when fish from these embryos die. The F2-Generation period is composed of three shorter periods; pre-smolt, smolt, and post-smolt.

Table 3. Captive broodstock monitoring and evaluation terminology.

	Example of approximate actual time

Period	period for fish maturing at age four
Captive Juvenile	Sep 95 - Jun 96
pre-smolt growth	Sep 95 - Apr 96
smoltification	Apr 96 - Jun 96
Captive Adult	Jun 96 - Sep 98
post-smolt growth	Jul 96 - Jun 98
maturation	Jun 98 - Sep 98
spawning	Sep 98
F1-Generation	Sep 98 - Sep 02
incubation	Sep 98 - Feb 99
juvenile rearing	Feb 99 - Apr 00
smolt release	Apr 00
adult return	Jun 02 - Sep 02
F2-Generation	Sep 02 - Sep 07
pre-smolt	Sep 02 - Mar 04
smolt	Apr 04 - Jun 04
post-smolt	Jul 04 - Sep 07

Each captive brood cycle will begin when natural fish are collected from the field, approximately 12 months after eggs were fertilized . Approximately one month after collection (13 months after fertilization) each fish will be tagged with a Passive Integrated Transponder (PIT). Fish will be taken from the troughs and anesthetized using 40-50 ppm MS-222. We will inject PIT tags manually using modified hypodermic syringes. Syringes and needles will be disinfected for 10 minutes in 70% ethanol prior to tagging. Fish will be allowed to recover in fresh water before being returned to their rearing facilities. PIT tags will allow us to identify individual fish during rearing and spawning. To minimize stress around the smolt period, handling of the fish will be minimized during April, May, and June (19, 20 and 21 months after fertilization). The exceptions to this are that, near the peak of smoltification fish will be hauled to either MML or BOH. Fish will receive food during these three months, mortalities will be removed from the rearing tanks, pathological treatments may be applied, and these tanks may need to be cleaned periodically.

Fish will be transferred to MML for seawater rearing, on or about June 1. The specific time of this transfer will be decided based on information from the literature, the time at which naturally-migrating Grande Ronde River fish leave the basin and reach Lower Granite Dam, the anticipated time they would reach the estuary, the results of seawater transfers from previous years, and the performance of captive broodstock fish in salinity tolerance tests. In addition, we will rear approximately 167 surrogates in conditions that mimic those of the captive brood fish. To time transfers into seawater, we will use these fish as surrogates in salinity tolerance tests.

After fish are transported to the MML, they will be placed into approximately 1.5 x 6.1 m circular tanks along with the water from the transportation vehicle. This water (0 ppt salinity) will be aerated to maintain d.o. levels of at least 8 ppm. Salinity's will be increased gradually so that the fish may acclimate to full strength salinity. Final conditions will be 26-29 ppt salinity, ≥ 90% oxygen saturation, and densities ≤ 24.3 kg/m^3.

Fish to be reared at BOH will be transported at the same time as those transferred to Manchester. Once at BOH fish will be placed into approximately 1.5 x 6.1 m circular tanks filled with well water (0 ppt salinity, ≥ 90% oxygen saturation, and ≤ 24.3 kg/m^3), also at temperatures similar to those at LGFH and to those in the transportation vehicle. With the exception of a freshwater environment, these fish will be reared under conditions as similar as possible to those experienced by fish at MML (i.e. tank size, tank type, loading factors, feeding schedules, etc.).

Post-smolt rearing will consist of a period of growth and maturation. During this rearing visual implant (VI) tags will be inserted into each fish when the population reaches a mean of approximately 250 mm in fork length. This should occur approximately 24-26 months post-fertilization. A VI tag will also be applied to insure identification of individual fish. The combination of PIT and VI tags should allow us to identify individual fish during rearing and spawning operations. Otherwise, we will attempt to minimize disturbances to the fish during post-smolt growth. The exceptions will be during visual monitoring, feeding, the removal of mortalities, cleaning of troughs, and pathological protocols.

Maturation of fish will be judged by gross morphological characteristics (i.e. coloration) and possibly ultrasound. Once near mid-July and once near mid-August, maturing fish will be separated from immature fish. Fish from MML will be transported to BOH. At BOH mature fish from MML and BOH will be held in Tanner Creek water so they can experience water temperature fluctuations and held under a simulated natural photoperiod to help synchronize their maturation. Peak maturation has occurred during the months of September and October, somewhat later than natural spawning fish. When fish become ripe they will be spawned, at BOH according to the general procedures used at LFH for Imnaha stock chinook. This includes stripping the eggs into a colander to remove ovarian fluid and water-hardening in 75 ppm Argentyne. After fertilization, F1- generation embryos from a given female will be trayed together and kept separate from embryos from other females. Eyed embryos will be transported to LFH for completion of incubation. Embryos will be kept distinguishable by female until fry hatch and are placed in Canadian troughs, sometime around February.

F1-generation fry will be reared in Canadian troughs following standard protocols for LFH. They will be moved into outdoor ponds around April. We will keep progeny from different treatments separate until tagging. They will be fin-marked and coded-wire-tagged during June and July. Progeny from each treatment group will be tagged to permit later identification. At full program, approximately 50,000 fish will be reared in each pond. Fish will be reared and sampled according to standard protocols at LFH and targeted for 44 fish/kg, or a mean fork length of 125 mm, at their release as yearling smolts.

In March, fish will be hauled to acclimation facilities located within the area of their natal stream where natural fish spawn. A proportionate number of fish from each evaluation group within a given stock will be mixed together at the time of transportation. Acclimation sites will be supplied with ambient stream water and fish at these sites given supplemental feed. In April, after a 20-30 day period of acclimation, fish will be released into the stream.

We anticipate that some of these fish will mature two, three, or four summers after they are released. Some of these fish may be captured in fisheries while others will return to the Grande Ronde River basin. Weirs will be placed near the mouth of the Lostine River, on Catherine Creek near the town of Union, and on the upper Grande Ronde River upstream of the town of La Grande. Of those adults returning, some will be allowed to spawn naturally and some may be collected at weirs for use as spawners in unseeded habitat. Adult returns from the captive broodstock program will not be incorporated into any conventional adult collection supplementation program.

F1-Generation fish that are allowed to spawn naturally may reproduce with other natural fish or other F1-Generation fish. The majority of the successful progeny produced from these matings are expected to migrate to the ocean as yearlings and return when they are 3, 4, and 5 years old. We will monitor the production and life-history characteristics of the F2-Generation fish.

Standard sampling will be conducted on pre-smolts to determine their relative abundance and to collect morphometric data and tissue for subsequent genetic analysis. Some fish may also be tagged so their migratory behavior can be evaluated. Juvenile migrant traps and weirs will be placed in the Lostine and upper Grande Ronde rivers as well as Catherine Creek. The production and timing of fish migrating to and from the ocean will be monitored. Characteristics of each study population will be evaluated prior to, during, and (potentially) after the captive broodstock program.

At all times, great care will be taken to minimize stress and any adverse impacts that monitoring may have on the fish. When possible, all variables will be associated with the tag code of an individual fish. The monitoring aspect of this program is designed to allow us the ability to make comparisons in our experimental evaluations, to monitor the basic progress of the fish, to detect areas of concern that may need our immediate attention, and to judge the adequacy of the benchmarks we have used to design the overall captive broodstock program (for example: a 75% egg viability of the captive brood adults). In general, along with the pathological sampling, we will record the length, weight, maturity, and gonadal status of all mortalities.

Fish Health Monitoring

There are no reliable non-lethal or non-invasive sampling techniques for infectious diseases that could potentially occur in the spring/summer chinook maintained in the captive broodstock program. Among the infectious diseases that could occur are: bacterial kidney disease (BKD), erythrocytic inclusion body syndrome (EIBS), bacterial cold water disease (CWD), enteric redmouth disease (ERM), bacterial gill disease (BGD), furunculosis, columnaris and infectious hematopoiesis necrosis (IHN). External fungus on the body or gills is always a threat and infestations by ectoparasites are possible. The two most survival-threatening infections are judged to be BKD and external fungus.

Because there are no reliable non-lethal or non-invasive sampling techniques for any of the agents causing the infections or infestations listed above, monitoring of morbidity and mortality is critical. This will provide the primary basis for the need for antibiotic or chemical treatments for diseases for which these therapies are appropriate. Daily observations of the fish by hatchery personnel and periodic inspections by fish pathology personnel may also help to identify conditions requiring treatment before clinical disease occurs. While there are capabilities for invasive sampling for some disease agents, these pose a greater risk and stress than can be justified for routine monitoring purposes.

g. Facilities and equipment

Lookingglass Hatchery
- All permanent facilities, utilities and maintenance at Lookingglass Hatchery
- Twelve (12) Canadian troughs for juvenile rearing
- Three (3) chillers for water temperature control
- PIT-tag stations with associated computer and software
- Water temperature monitoring system including an integrated S.C.A.D.A. system
- Laboratory facilities
- Pathogen-free water supply
- One (1) diesel powered emergency electrical backup system
- One (1) vacuum system for cleaning captive brood troughs

Bonneville Hatchery

- One (1) 972 m^2 captive broodstock building with office, storage, rearing and spawning facilities
- Fifteen (15) 20 foot diameter rearing tanks
- Four (4) 10 foot diameter rearing tanks
- UV water purification system
- Well water at 10^o to 13^{oC}
- Equipment and storage facilities for cryopreserved sperm
- Vehicles and containers for transporting water-hardened eggs to Irrigon Hatchery

Fish Transport
- Extra large (151 l.) coolers for transporting collected parr
- One (1) Pickup truck with a 757 l. slip-in portable transport tank
- One(1) 1514 l. portable transport tank mounted on a trailer
- One (1) 10,600 l. fish liberation truck
- All other transport-related supplies, equipment and the associated equipment maintenance for safely moving fish

Fish Research
- Desk top and laptop computers and associated software for program tracking and report preparation
- Underwater camera and combination VCR/TV for salmonid morphology monitoring
- Electronic scales, PIT tag detectors, oxygen and temperature monitoring equipment
- One (1) suburban for transport of personnel and equipment
- One (1) cargo trailer for transporting equipment to various collection and monitoring locations

h. Budget

The personnel component of the budget includes staff needed at Bonneville and Lookingglass fish hatcheries to run the broodstock facilities and staff needed for collection, research, M&E and fish health. S&S costs are needed for collection, rearing, spawning, tagging, fish health supplies and for analysis and writing. O&M is primarily for power to run chillers at LFH. The indirect rate is based on agreement of ODFW and the Federal Government.

Section 9. Key personnel

Richard W. Carmichael, Program Leader, 0.1 FTE

Education

B.S., Fisheries Science, Oregon State University, 1979
M.S., Fisheries Science, Oregon State University, 1984

Current employment

Oregon Dept. Fish and Wildlife, Fish Research and Development, La Grande, OR. July 1990 - present. Program Leader - Executive Manager for NE Oregon Fisheries Research and Development Program. Primary responsibilities are to develop and direct implementation of a complex research program to evaluate success of protecting, reestablishing, and restoring ESA listed and non-listed stocks in eastern Oregon. Oversees the work of 14 full-time fisheries biologists and up to 8 projects, and represent ODFW on regional and national scientific committees. Adjunct professor at Eastern Oregon University.

Past employment

Fisheries Research Biologist (Project Leader), Oregon Department of Fish and Wildlife, La Grande, OR. December 1983 to July 1990.
Fisheries Research Biologist (Assistant Project Leader), Oregon Department of Fish and Wildlife, La Grande, OR. March 1983 to December 1983.
Project Assistant (Experimental Biology Aid), Oregon Department of Fish and Wildlife, La Grande, OR. Oct. 1982 to March 1983.

Expertise

Expertise in fisheries research project development and implementation, personnel management, budget development and tracking, technical report writing, natural production and supplementation research, hatchery effectiveness, hatchery and wild fish interactions, life history, harvest assessment, stock assessment, passage evaluation, straying, captive broodstock, statistical analysis, coded-wire tag implementation and assessment, bass and trout ecology, creel censusing.

Recent publications

1998. Status review of the spring chinook salmon hatchery program in the Grande Ronde River Basin, Oregon. Lower Snake River Compensation Plan Status Review Symposium, USFWS, Boise, ID.

1998. Status review of the spring chinook salmon hatchery program in the Imnaha River Basin, Oregon. Lower Snake River Compensation Plan Status Review Symposium, USFWS, Boise, ID.

1997. Straying of Umatilla River hatchery origin fall chinook salmon into the Snake River. (R. W. Carmichael). *In* Genetic effects of straying of non-native hatchery fish into natural populations (R. S. Waples, convenor). National Oceanic and Atmospheric Administration, Seattle, WA.

1995. Status of supplementing chinook salmon natural production in the Imnaha River basin. *In* Uses and effects of cultured fishes in aquatic ecosystems (H.L. Shramm, Jr., and R.G. Piper, eds.)

1994. A comparison of the performance of acclimated and direct stream released , hatchery-reared steelhead smolts in Northeast Oregon. (Whitesel, T.A., P.T. Lofy, R.W. Carmichael, R.T. Messmer, M.W. Flesher, and D.W. Rondorf) Pages 87-92 *in* High performance fish (D.D. MacKinlay, ed.); Fish Physiology Section, American Fisheries Society, Fish Physiology Association, Vancouver, British Columbia, Canada.

Timothy A. Whitesel, Project Leader, 0.3 FTE

Education

1990 - Ph.D., Biological Sciences, University of Rhode Island
1987 - M.S., Zoology, University of Rhode Island.
1985 - B.A., Philosophy, State University of New York, College at Fredonia
1983 - B.S., Biology, State University of New York, College at Fredonia

Recent Professional Experience

July 1991 - present. Project Leader Captive Broodstock and supplementation studies working for the Oregon Dept. Fish and Wildlife, Fish Research and Development, La Grande, OR.
January - July 1991. Postdoctoral Research Associate, under the guidance of Dr. Kenneth Able, Center for Coastal and Environmental Studies, Rutgers University.
September - December 1990. Postdoctoral research Fellow, under the guidance of Dr. Howard E. Winn, Graduate School of Oceanography, University of Rhode Island.

Recent Teaching Experience

March, 1995 - present. Adjunct Professor, Biology Program, Eastern Oregon University, La Grande, OR
October, 1993 - March, 1994. Tutor, Eastern Oregon State College, La Grande, OR.
June - August, 1992 and June - August 1994. Mentor, Oregon Department of Fish and Wildlife, La Grande, OR.
February - June 1991. Adjunct Professor, Biology Program, Stockton State College of New Jersey, Pomona.

Professional Affiliations
American Fisheries Society
Sigma Xi

Selected publications

1997. Accuracy of fork length estimates for Chinook salmon and Steelhead in Compartmentalized and Standard Hatchery Raceways. Prog. Fish-Culturist. (M. Hayes, R.W. Carmichael, M. Keefe, T.A. Whitesel)

1992. Plasma thyroid hormone levels in migratory and lake-resident coho salmon juveniles from the Karluk River system, Alaska. Trans. Amer. Fish. Soc. 121:199-205. (T.A. Whitesel)

Section 10. Information/technology transfer

Information will be transferred through a variety of avenues including:

Research reviews
Reports - monthly, quarterly, annual
ESA annual reports
ESA permits
Technical manuscripts
Technical presentations
Hatchery effectiveness workshops
Public presentations (schools, sportsman and civic groups).

There are multiple decision levels that the information will be used at. At the field biologist level information will be transferred and used by regular communication and contact. At the agency level information will be input into the formal decision process by written communication. Information will be input into the NMFS recovery plan process through written communication and into the CBFWA process by verbal and written communication. The format of feedback will be description of results, recommendations, and formal publication. We have established multiagency management oversight teams for decision making.

Congratulations!